EXHIBIT H
REDACTED

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CONTAINS CONFIDENTIAL ATTORNEY EYES ONLY INFORMATION SUBJECT TO PROTECTIVE ORDER

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF PENNSYLVANIA

LAMBETH MAGNETIC STRUCTURES, LLC, Plaintiff, v. SEAGATE TECHNOLOGY (US) HOLDINGS, INC. and SEAGATE TECHNOLOGY LLC, Defendants.	Civil Action No. 2:16-cv-00538-CB Judge Cathy Bissoon **CONTAINS CONFIDENTIAL ATTORNEY EYES ONLY INFORMATION SUBJECT TO PROTECTIVE ORDER**

REPLY EXPERT REPORT OF DR. WILLIAM ALAN THOMAS CLARK TO THE EXPERT REPORTS OF DR. ERIC STACH AND DR. ERIC FULLERTON

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I. INTRODUCTION

1. I, Dr. William Clark, resident at 5696 Morlich Square, Dublin, OH, 43017, have been retained by counsel for Plaintiff Lambeth Magnetic Structures, LLC ("LMS") to determine: the composition of certain material layers; the crystal structure and texture for certain FeCo and NiFe layers; whether the NiFe layers directed the growth of the FeCo layers deposited directly on top of the respective NiFe layers; the presence of crystallographic orientational variants; whether there is an unequal amount of variants in a six variant system in the lower FeCo layer of the write pole; and the fractional distribution of the different orientations of the crystallites in the lower FeCo layer I previously provided an expert report in this matter on May 2, 2018 ("Clark Initial Expert Report").

2. On July 16, 2018, Dr. Eric Stach and Dr. Eric Fullerton provided expert reports at Seagate's request. My conclusions and opinions contained herein are in response to Dr. Stach's and Fullerton's July 16, 2018 reports. Unless indicated otherwise, the conclusions and opinions in my Clark Initial Expert Report remain unchanged and I reserve the right to rely on any of these conclusions and opinions in this report.

3. The materials I considered in reaching the conclusions and opinions in my Clark Initial Expert Report were identified in Appendix A to that report.

4. My qualifications, compensation and expert testimony in the last four years were set out in my Clark Initial Expert Report.

5. The legal standards I used in my infringement analysis are set forth in my Clark Initial Expert Report and I have applied them herein as well.

6. I am prepared to testify to the matters set out in this report at trial, as well as those set forth in my Clark Initial Expert Report, as explained therein.

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II. OPINIONS

7. In paragraph 89, Dr. Stach states that Dr. Clark "focuses on the 200 diffraction rings to conduct an analysis of the amount of bcc(110) crystals at certain angles in a sample." I disagree. I do not use the 200 diffraction rings to analyze the "amount of bcc (110) crystals." The 200 rings are used to set up the dark field images used to determine the fraction of crystallites whose {200} planes are in the Bragg position with respect to the incident beam, regardless of the overall crystal orientation.

A. My Opinions Regarding Crystalline Structure and Texture of the NiFe Layers Remain Unchanged[1]

1. Sample S0GPPC ([redacted])

a) Lower NiFe Layer

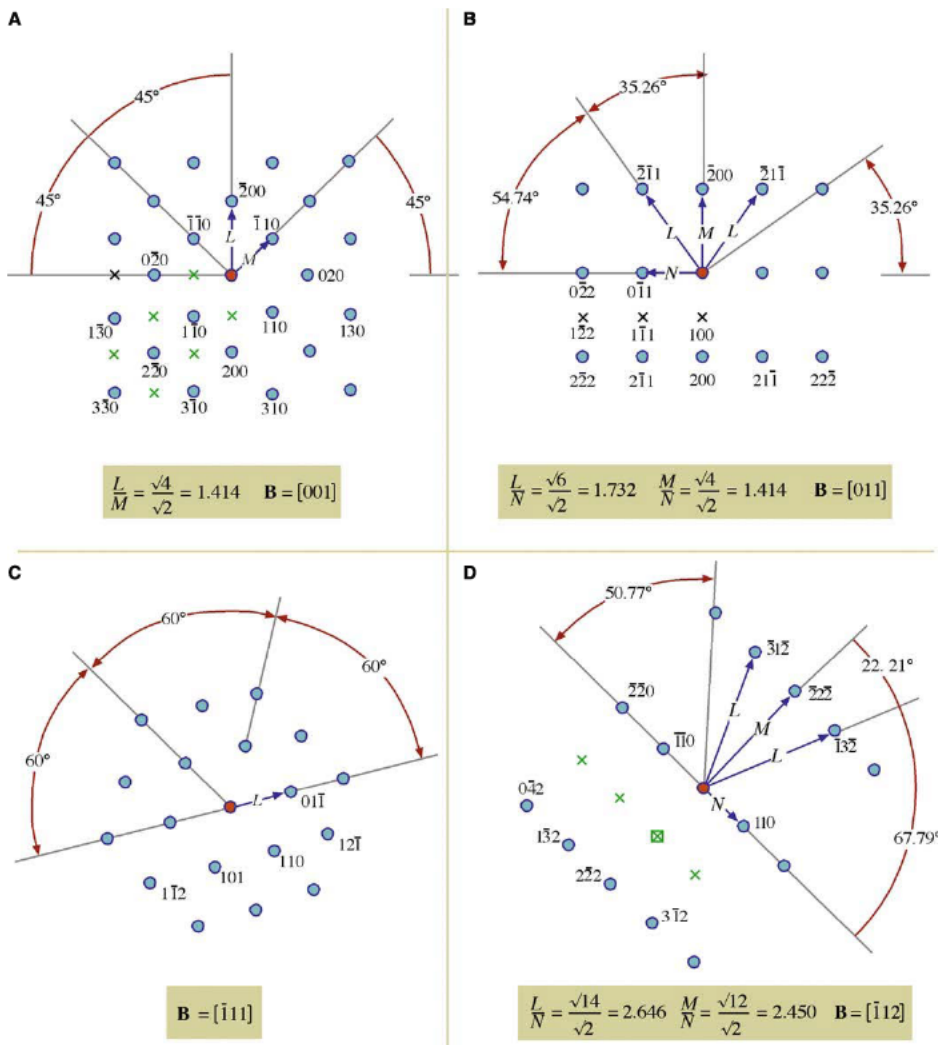
8. In paragraphs 110 – 118 of his report, Dr. Stach is critical of my analysis of the FFTs. In paragraph 113, Dr. Stach states, "Dr. Clark does not describe the particular methodology he applied for making his comparison" and provides examples of why my methodology is supposedly wrong. I disagree. The particular methodology is described in detail in the Clark Initial Expert Report at paragraphs 87-105.

9. In addition, since FFTs are taken from very small areas, I emphasize the following: the BCC {111} diffraction pattern is very distinct in that there is no other pattern in BCC that is like the hexagonal form that conforms to the pattern on the right in reproduced Figure 42 from the Clark Initial Expert Report below. Examination of the standard diffraction

[1] Dr. Eric E. Fullerton in his Expert Report ("Fullerton Expert Report") raises many of the same issues Dr. Stach does. My replies in response to Dr. Stach apply to Dr. Fullerton as well. To the extent I provide separate additional responses to Dr. Fullerton, they can be found below in the sections titled "Response to Dr. Fullerton."

(continued...)

patterns from BCC materials shows that only one low-index pattern exhibits anything close to a hexagonal morphology, and that is {111}, as shown here[2]:



Further, there are two higher intensity areas (circled in red on the left in reproduced Figure 42 below), that are aligned perpendicular to the NiFe template/FeCo interface. They are consistent in spacing with the {111} NiFe planes and indicate the orientation of the NiFe surface.

[2] D.B.William and C. B.Carter, *Transmission Electron Microscopy,* (2009), p. 219

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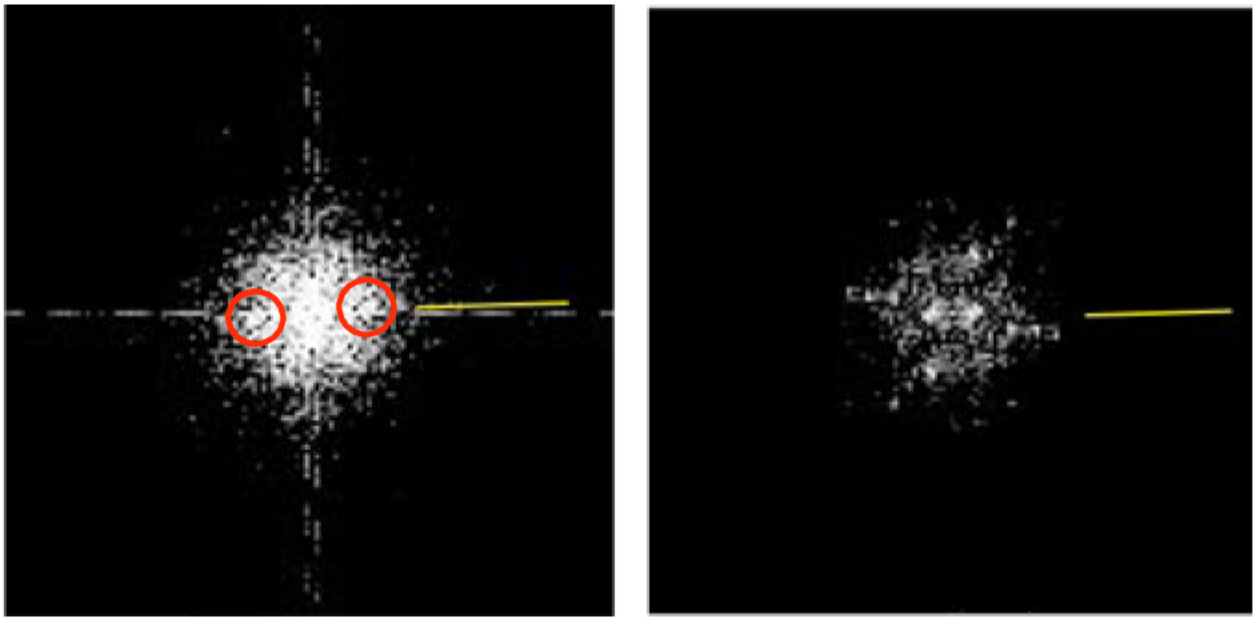

Figure 42 from the Clark Initial Expert Report (annotated).

10. I disagree with Dr. Stach's analysis in paragraphs 118–122. Other FFTs were provided as supplements to the report and they all show standard diffraction patterns. For example, in Figure 102 from the Initial Clark Expert Report, cited on page 87 of Dr. Stach's report, the standard diffraction pattern matches the FFT well, once it is rotated into the correct position. Furthermore, the measurement of the spacings of the observed diffraction spots in this figure confirms the matching.

11. In addition, Dr. Stach's allegation in paragraph 122 that "[m]aterials deposited at a thickness of [redacted]—the target for the lower NiFe layer of Seagate's SP2X write head design—are almost certainly too thin to have developed any significant crystal texture" is purely speculative without any experimental evidence.

12. Further, Dr. Stach's allegation is demonstrably wrong. In response to paragraph 122, I stand by my initial opinion that the NiFe is crystalline, which is corroborated by the high resolution FFTs taken on August 1, 2018, which are shown below. As can be seen from the images, the lattice fringes continue from the template into the FeCo layer, demonstrating crystallinity. The FFTs shows some texture in the growth direction of the FeCo. The red lines

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delineate boundaries between crystallites in the template layer. The average grain diameter in the template layer is ~ 5-7nm, and is comparable to, or smaller than, that in the FeCo layer.

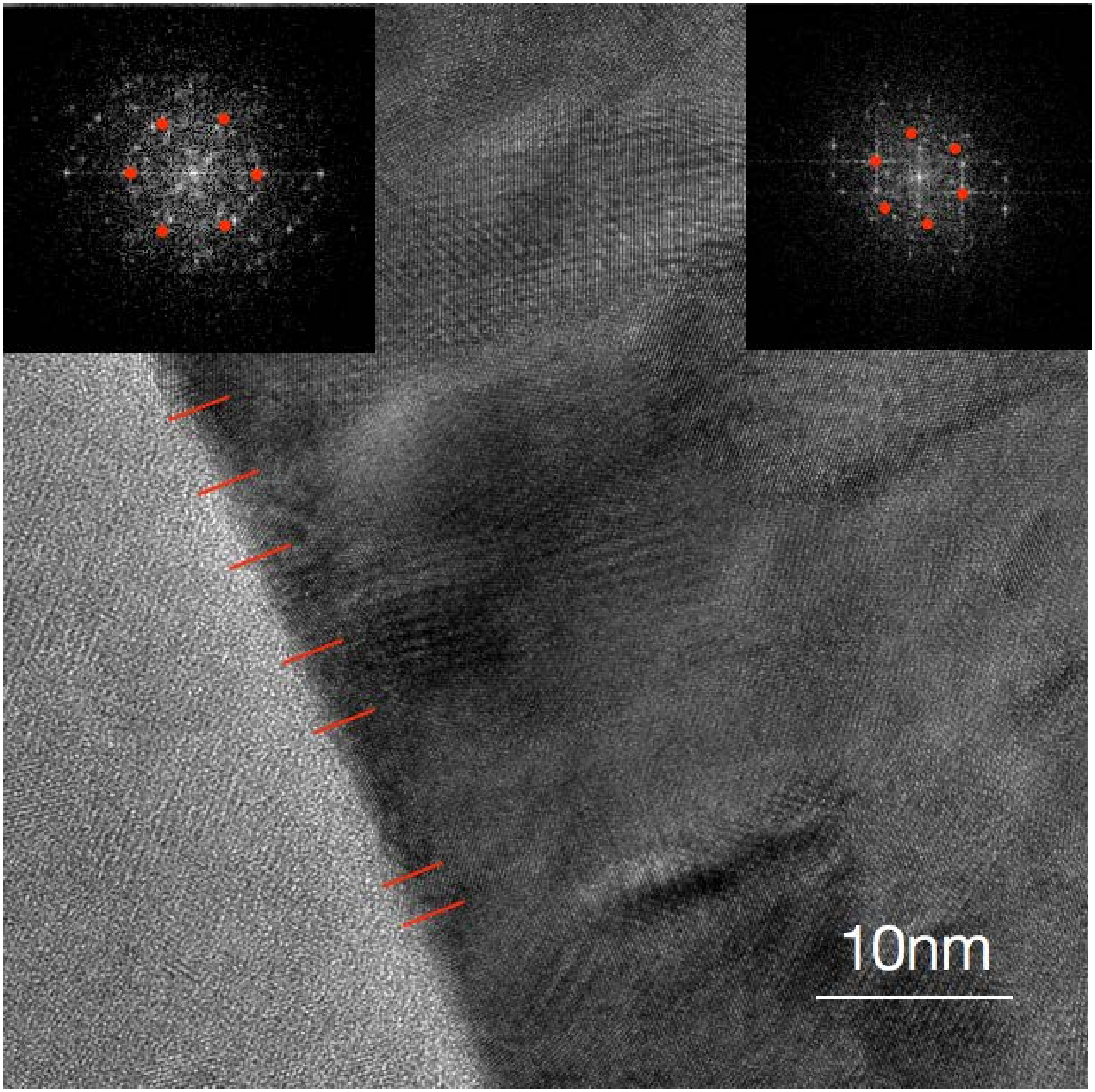

FIG. 1 – S0GPPC – cross section, with FFT superimposed[3]

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[3] Microscope imaging conditions for these images taken on August 1, 2018 are included as Appendix 1 to this report.

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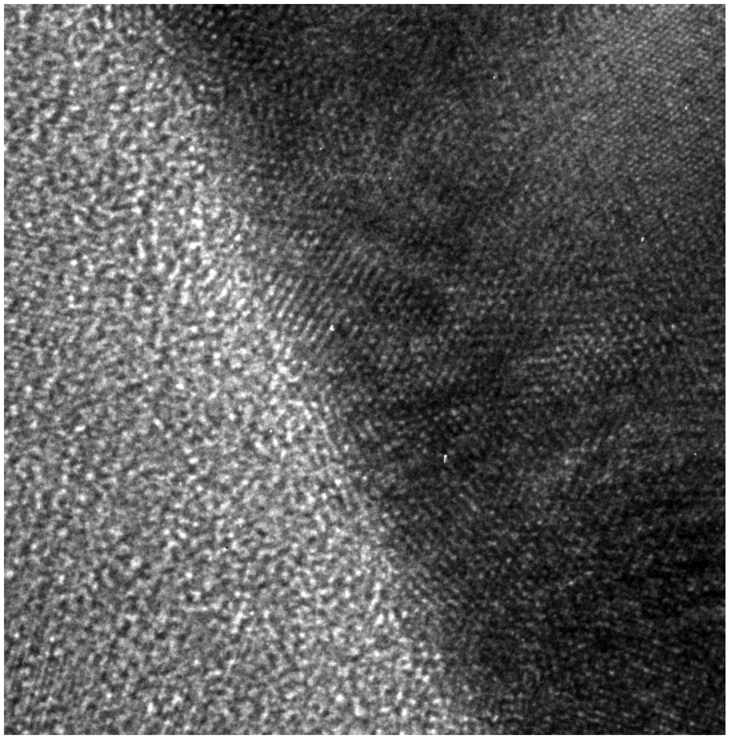
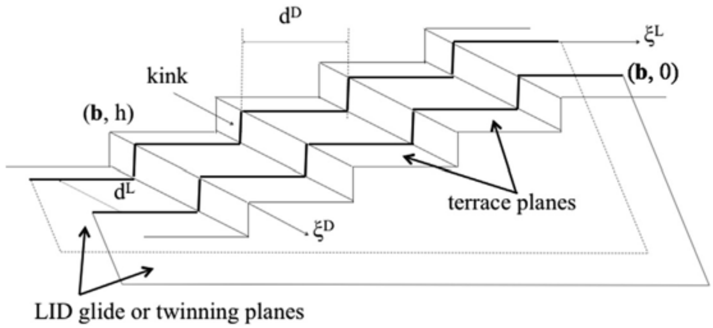


FIG 2 – Enlargement of the red box in the image above, in the FeCo/NiFe interface region, showing the continuity of the lattice fringes from the template to the FeCo.

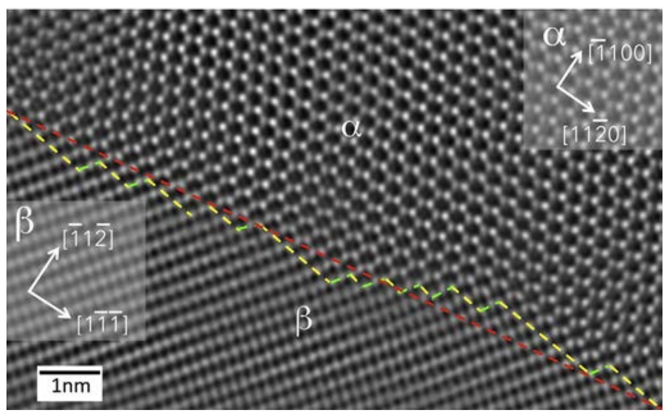
13. I disagree with Dr. Stach's allegations in paragraph 125-127. The growth direction of the FeCo crystals is very clear from the image, and are either at, or close to, perpendicular to the template. There are distinct, parallel, directions in the NiFe and FeCo crystallites, and these are consistent with <110>BCC and <111>FCC direction, as predicted for epitaxial growth.

14. Furthermore, Dr. Stach, in his haste to dismiss my observations, uses a flawed analysis. It is entirely feasible (and even common) for the actual template interface plane to differ significantly from the {111} planes in a template, and to be inclined by some angle to the substrate on which they are deposited. In this case the interface would consist of coherent {111} terrace planes, separated by a series of ledges, as shown below:



See, e.g., Zheng et al, Determination of the structure of α-β interfaces in β-Ti alloys, Acta Mat. 150 (2018) at 25-39.

This is commonly observed in many systems and leads to an interface in a form shown below, in this case between HCP and BCC crystals.



(*Ibid*.)

Thus, Dr. Stach is incorrect in asserting that “diffraction spot[s] have to be exactly perpendicular to the interface.” (Stach ¶ 128).

14. I disagree with Dr. Stach’s allegations in paragraph 130. I have shown multiple FFTs containing {111} diffraction spots and observation of these spots lying normal to the template surface was typical. Thus, I have shown that a lower NiFe layer exhibits (111) texture.

15. Furthermore, 1.1% percent sample of the lower NiFe layer (assuming Dr. Stach’s calculation of the sample percentage is correct) represent an adequate sample to determine the lower NiFe layer texture. Given the very fine scale of the microstructure, even limited area FFTs are representative of the full microstructure.

16. In paragraph 142, Dr. Stach selects a single image to try to dispute the many observations of columnar growth present in the samples I provided. Not only is Dr. Stach wrong about this one sample in Figure 38 of the Initial Clark Expert Report, but this is also a flawed methodology that seeks to set aside the volume of observations supporting this morphology based on only one example from the volume. A single high resolution image does not contain enough FeCo grains on which to base a description of the overall growth directions. Figure 35, for example shows the bamboo growth morphology very clearly, that its predominant growth direction is normal to the template layer, and that it extends over the entire sample.

17. In paragraph 143, Dr. Stach denies that lattice fringes that continue undeviated from the FeCo through the template layer are evidence of a mutual orientation relationship. He is wrong as this particular point has been well established in countless publications.[4]

b) Upper NiFe Layer

18. In paragraphs 145-179 of his report, Dr. Stach is critical of my analysis of the "Upper NiFe layer."

19. In paragraphs150-155, he attempts to show that the FFT obtained from the NiFe layer is not FCC, by overlaying it with a purported {111} BCC pattern. However, in doing so, he obscures the FCC spots that are captured along with the BCC ones. The diffraction spots associated with the {111}BCC pattern which are marked in Dr. Stach's overlay are unavoidably included in this FFT due to the close proximity of the FeCo, which is BCC, to the NiFe layer. Taking account of the appearance of overlapping diffraction spots, below is the same FFT, with only those spots marked that come from the {111}FCC diffraction pattern.

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[4] *See, e.g.*, D.B. Williams and C.B. Carter, *Transmission Electron Microscopy*, (2002) chap. 28, pp 500 et seq.

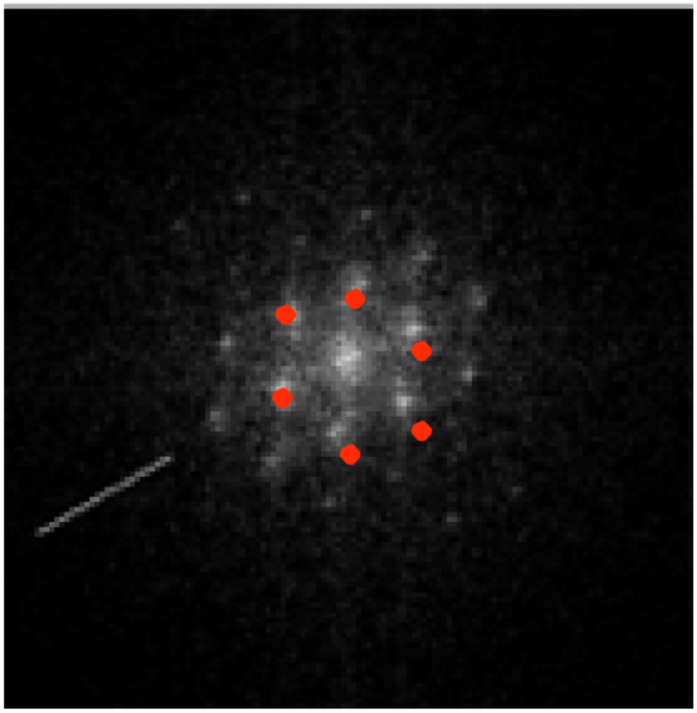

Fig. 44(b) from Clark Initial Expert Report.

20. Dr. Stach also avoids discussing the FFTs from the two FeCo layers on either side of the NiFe, since these clearly show {111} BCC patterns, with a <110>BCC direction normal to the NiFe layer and along the columnar growth direction of the FeCo crystals. In doing so, he carefully skirts the issue that the FeCo layers on either side of the NiFe display identical orientations and are consistent with the NiFe having a {111} FCC orientation thus reinforcing the epitaxial growth habit of the FeCo.

21. I disagree with Dr. Stach's analysis in paragraphs 158-162. Other FFTs were provided as supplements to the report and they all show standard diffraction patterns. For example, the "FFT of middleNi5 at B" in my Appendices, the standard diffraction pattern matches the FFT well, once it is rotated into the correct position. Furthermore, the measurement of the spacings of the observed diffraction spots in this figure confirms the matching. As an example, below is the FFT of the NiFe layer from another image, and it conforms well to the {111}FCC pattern.

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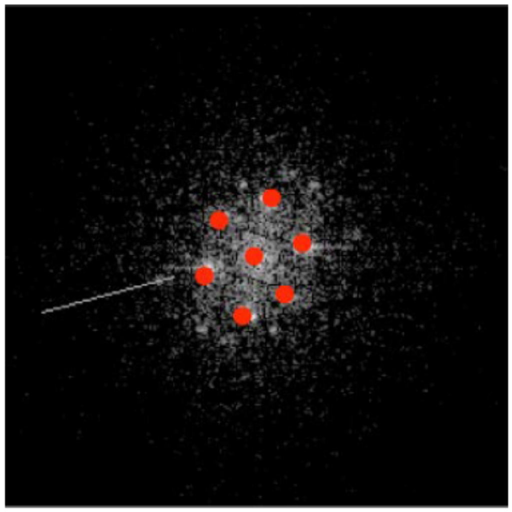
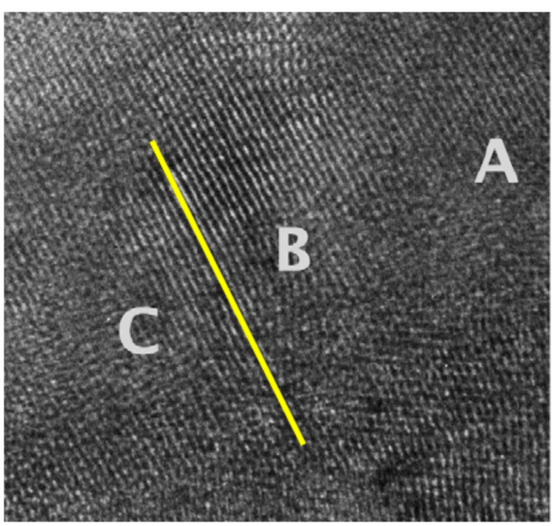


(FFT of MiddleNi5 at B)

22. In addition, Dr. Stach's allegation in paragraph 162 that "Materials deposited at a thickness of [redacted]—the target for the upper NiFe layer of Seagate's SP2X write head design—are almost certainly too thin to have developed any significant crystallographic texture, and may even be too thin to have a distinct crystalline structure" is purely speculative without any experimental evidence. HREM images of the upper NiFe layer at B clearly show the continuity of lattice fringes from the FeCo on either side of it, through the NiFe. In the image below, a set of lattice fringes in the direction of the yellow line can be seen in all three layers, A and C, the FeCo, and B, the NiFe:



23. I disagree with Dr. Stach's allegations in paragraphs 163-172. Determining two pairs of parallel directions in the NiFe and FeCo is enough to establish their relative orientation. In this case we find one pair of parallel directions from the diffraction pattern normal, {110}FCC||{111}BCC, and a second pair, orthogonal to the first, from the parallel directions in the plane of the diffraction pattern, <111>FCC||<110>BCC. A third pair of parallel directions is obtained for each crystal from the cross product of the two already determined, and in this way provide a complete description of the orientation of the NiFe and FeCo. In this case, that orientation is consistent with Kurdjumov-Sachs, and epitaxial growth in a <111>FCC/,110>BCC direction.

24. At the upper NiFe layer, the orientation of the FeCo crystallites is unchanged as they grow across it. This implies that there is a mutual orientation relationship between the two phases, and this is supported by the diffraction patterns in Fig. 44 of my Clark Initial Expert Report, for reasons explained in the previous paragraph. The upper NiFe layer is far from macroscopically flat, but within that overall general shape, the {111}FCC terraces provide a basis for reinforcing growth direction of the FeCo crystallites into the upper half of the head. This can be illustrated by the continuity of the lattice fringes across the NiFe layer, as seen in Fig. 43 of my Clark Initial Expert Report. The discrepancy between the apparent plane of the NiFe layer, and the epitaxial growth direction can be accounted for by the argument made in paragraph 14. For all these reasons, I do not accept Dr. Stach's conclusions.

25. I disagree with Dr. Stach's allegations in paragraph 173. I have shown multiple FFTs containing {111} diffraction spots and observation of these spots lying normal to the template surface was typical. Thus, I have shown that the upper NiFe layer exhibits (111) texture.

26. In paragraphs 174-181, Dr. Stach makes broad, unsupported generalizations. In materials science we continually describe the microstructure, and derive the properties, of

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macroscopic objects based on examining a very small sample in the TEM. This is because even a sample small enough for TEM examination is many, many, orders of magnitude larger than the scale of the microstructure, so that even in that small sample, we have a statistically valid representation of the entire material.

27. Furthermore, a 0.8% percent sample of the upper NiFe layer (assuming Dr. Clark's calculation of the sample percentage is correct) represents an adequate sample to determine the upper NiFe layer texture. Given that the microstructure of the FeCo exhibits repetitive columnar growth across the write head, establishing the orientation relationship between the NiFe and the FeCo columns in one part of the sample can reasonably be extrapolated to the remainder. A sample of 0.8% is representative of the whole when it contains features observed throughout the entire head.

28. In paragraphs 183-189, Dr. Stach seems unwilling to accept that the delineated areas in Figures 39 and 40 of the Clark Initial Expert Report enclose the upper NiFe layer, even though the layer is visibly distinct in this image and in all lower magnification images, as well as in the EDS analyses. The FFTs have already shown a {111} BCC diffraction pattern, with at <110>BCC direction normal to this intermediate NiFe layer.

29. In paragraph 188, Dr. Stach contradicts the very definition of epitaxial growth. The NiFe layer has a special orientation relationship with the two FeCo layers on either side of it. If the NiFe "has no effect," as Dr. Stach alleges, on the growth of the upper FeCo layer and so forms no mutual orientation relationship, then it would not conform so closely to the FeCo structure on both sides of it.

30. In paragraphs 190-191, Dr. Stach misunderstands the ring patterns I show in the Clark Initial Expert Report. The ring patterns do not show, and neither do I claim that they show, the texture of either the BCC or FCC layers. They are used to identify crystallites with

{200} planes oriented in the Brag position with respect to the electron beam, and hence <200> directions lying in the plane of projection.

31. In paragraph 192, Dr. Stach misunderstands the geometry of the plan-view TEM microbeam images. These images are very thin, so it is unlikely that they contain more than one layer of the write head structure. Thus, they will not show diffraction patterns from the NiFe and FeCo layers together.

32. In paragraph 193, Dr. Stach states that I "apparently did not consider any XRD data from any source in connection with [my] analysis of whether the NiFe layers in sample S0GPPC contain material with a (111) texture." There is no requirement that XRD testing be used to prove infringement of the Asserted Claims. Further, XRD testing was not conducted on these particular samples because of the limitations imposed by the small dimensions of the heads.

(1) Response to Dr. Fullerton

33. In paragraph 271, Dr. Fullerton says, "For example, Dr. Clark does not attempt to identify the center diffraction peak, which is a critical step in this type of analysis (diffraction peak distances and angles are measured relative to the center diffraction peak)." A center diffraction peak is obvious to one of ordinary skill in the microscopy field and even to those who are not.

34. In paragraph 273 of his Report, Dr. Fullerton states that "the NiFe FFT most closely resembles the diffraction pattern for an amorphous material—i.e., a material with no crystal structure (and thus, no predominate crystallographic orientation)." I disagree. The presence of any diffraction spots in the pattern, no matter how noisy, indicate crystallinity. Further, Dr. Fullerton also claims "there is no scientific basis for Dr. Clark to assert that the NiFe layer has any 'predominate' crystal orientation (let alone a predominately (111) crystal orientation) after having measured only 1.1% of the overall layer. Such a conclusion is akin to a

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person concluding that a beach predominately comprises grains of black sand based on the fact that a single sample grain from that beach was found to be black." Fullerton ¶ 286. His example misapplies the data I provided. I am not saying that based on one black grain of sand you can conclude that the beach that has billions of grains of black sand.

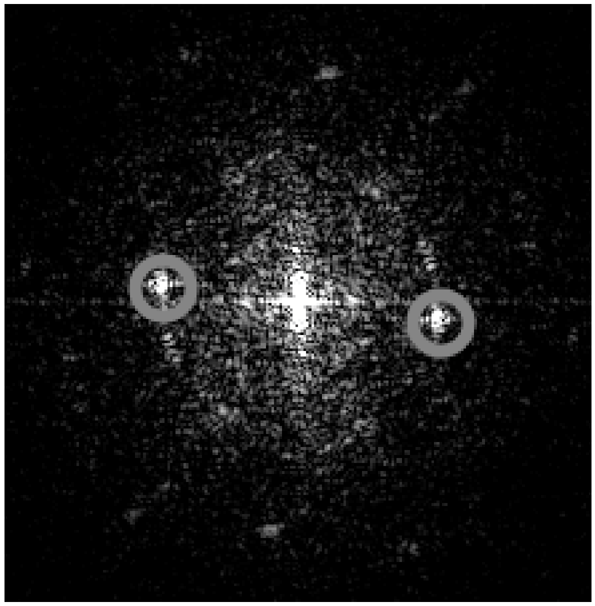
35. In paragraphs 295-298, Dr. Fullerton states that the "NiFe FFT matches the {111}BCC diffraction pattern." He is wrong. The {110}FCC pattern is a good match to NiFe pattern, once account has been taken of the spots from the FeCo{111} pattern that are unavoidably found in it because the NiFe layer is so thin. The differences between the two are small, and care must be taken to align the spots correctly. However, I do not share Dr. Fullerton's conclusion.

2. Sample S2MMMC ([redacted])

a) Lower NiFe Layer

36. In paragraphs 197-207 of his report, Dr. Stach is critical of my analysis of the FFTs. In paragraph 201, Dr. Stach states, "Dr. Clark does not describe the particular methodology he applied or which 'faint diffraction spots' in the FFT he has discerned that allegedly provide the basis for his comparison" and provides examples of why my methodology is supposedly wrong. I disagree. The particular methodology is described in detail in the Clark Initial Expert Report at paragraphs 133-150.

37. In paragraph 199, contrary to Dr. Stach's wrong interpretation of my analysis, I do conclude based on my analysis and testing that the crystal structure of the lower NiFe layer "is FCC" because the arrangement of the diffraction spots that are visible most closely resemble the {110} FCC pattern, as shown below. Furthermore, my opinion that the spots that are visible are most likely {110}FCC was based on measurements of the spot spacings.



(FFT from Fig. 72 of Clark Initial Expert Report, annotated with diffraction spots normal to the template surface highlighted circled.)

38. To further illustrate the points made above and in the Clark Initial Expert Report a higher resolution FFT are shown below.

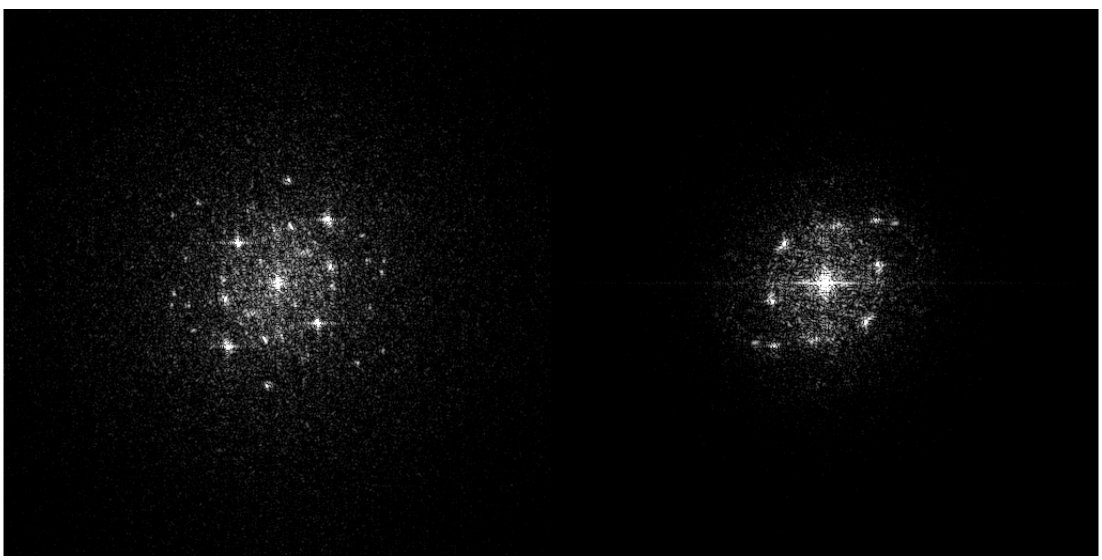
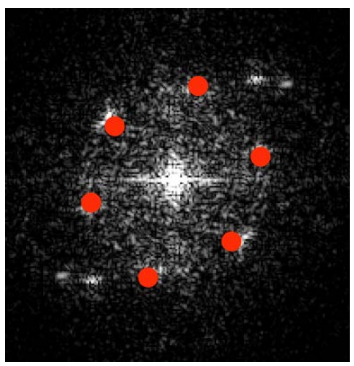


FIG 3 – FFTs from 18.08.14 at point 3. Pattern on the left is from the FeCo, that on the right from the NiFe.

39. In paragraph 203-204, Dr. Stach annotates the NiFe FFT against a standard {110}FCC diffraction pattern and clearly identifies and marks the two highly visible spots that are consistent with the {111}FCC diffraction pattern, just as I did in the Clark Initial Expert

Report. In addition, he claims there are "no spots" where there are indeed faint spots present that he simply ignores.

40. I disagree with Dr. Stach's analysis in paragraphs 207-211. Other FFTs were provided as supplements to the report and they all show standard diffraction patterns. For example, in "Sample S0GPPC - Frameright31T FFT" of Exhibit F of Dr. Stach's report, the standard {110}FCC diffraction pattern matches the FFT well, once it is rotated into the correct position. Furthermore, the measurement of the spacings of the observed diffraction spots in this figure confirms the matching. For comparison, we include another FFT from the NiFe layer, marked to show its similarity to the {110}FCC pattern.



FFT of 18.08.14 Acquire 3T, Appendices to Clark Initial Expert Report.

41. In addition, Dr. Stach's allegation in paragraph 211 that "Materials deposited at a thickness of [redacted]—the target for the lower NiFe layer of Seagate's SP2X write head design—are almost certainly too thin to have developed any significant crystallographic texture" is purely speculative without any experimental evidence.

42. I disagree with Dr. Stach's allegations in paragraph 215-217. The growth direction of the FeCo crystals is very clear from the image, and are either at, or close to, perpendicular to the template. There are distinct, parallel, directions in the NiFe and FeCo crystallites, and these are consistent with <110>BCC and <111>FCC direction, as predicted for epitaxial growth. It is also to be expected that epitaxial growth on a nominal {111}FCC surface

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will occur in a range of directions, since the template surface itself is not flat. The same description of the template surface given in paragraph 13 above applies here.

43. Furthermore, a 0.165% percent sample of the lower NiFe layer (assuming Dr. Stach's calculation of the sample percentage is correct) represents an adequate sample to determine that lower NiFe layer texture. Given that the microstructure of the FeCo exhibits repetitive columnar growth across the write head, establishing the orientation relationship between the NiFe and the FeCo columns in one part of the sample can reasonably be extrapolated to the remainder. A sample of 0.165% is representative of the whole when it contains the features observed throughout the entire head.

44. Other points and statements made in the Lower NiFe section for the S0GPPC sample ([redacted]) above also apply to this product.

b) Upper NiFe Layer

45. In paragraphs 232-268 of his report, Dr. Stach is critical of my analysis of the "Upper NiFe layer."

46. In paragraphs 232-239, Dr. Stach raises many of the same issues that he raised for the S0GPPC ([redacted]) product. My points and statements made in the Upper NiFe section for the S0GPPC ([redacted]) product above also apply to this product.

47. In paragraph 235, Dr. Stach criticizes me for not marking the center spot. The center spot is clearly in the middle of each pattern in Figure 74 of the Clark Initial Expert Report and would be obvious to any person having ordinary skill in the microscopy field. Further, the yellow lines in the same figure indicate that the directions are parallel in the three layers and lie normal to the interface.

48. In paragraphs 240-245, Dr. Stach raises many of the same issues that he raised for the S0GPPC ([redacted]) product. My points and statements made in the Upper NiFe section for the S0GPPC ([redacted]) product above also apply here. I also note that Dr. Stach

chose to ignore the description of the two FeCo FFTs, which are unambiguously {111} BCC, and show the continuous orientation of the FeCo columnar grains across the NiFe layer. Were the NiFe layer to have no influence on the orientation, this continuity would not be expected.

49. In paragraphs 246-272, Dr. Stach raises many of the same issues that he raised for the S0GPPC ([redacted]) product. My points and statements made in the Upper NiFe section for the S0GPPC ([redacted]) product above also apply here.

50. In response to paragraph 251-259, I note that the requirements for the unambiguous establishment of an orientation relationship is uniquely fixed by the determination of two pairs of directions, one in each crystal, that are parallel to each other. There are two such pairs for the FeCo - one the FFT normal, and the other the common direction in the plane of the diffraction pattern. In addition, the NiFe can also be included to give the complete analysis.

51. In paragraphs 260-268, Dr. Stach again takes issue with the evidence of lattice fringes in the two FeCo layers that are continuous across the upper NiFe interface. His argument again is without validity, since there is clearly a NiFe layer present, as is confirmed at lower magnification, and by the EDS x-ray analysis. Simply to claim that the FeCo grains "grow through" the NiFe layer runs counter to the observed images and FFTs. The NiFe plays a role in maintaining the orientation of the FeCo across the NiFe layer.

3. Sample SBRD8K ([redacted])

15. For this product, Dr. Sinclair raises many of the same issues that he raised for the other products. My points and statements made for the other products also apply to this product.

B. Reply to Dr. Stach's Criticism of My Conclusions Relating to the Crystalline Structure, Texture, Variants, and Symmetry Broken Structure in Certain FeCo Layers in Samples S0GPPC, S2MMMC, and SBRD8K

1. Sample S0GPPC ([redacted])

52. With respect to Dr. Stach's allegations in paragraphs 340-349, I am able to recognize standard diffraction patterns from 45 years of experience in this field, and all my

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conclusions can be verified by comparison with published diffraction patterns (see e.g., "Andrews, Dyson, Keowns," or "William and Carter" references from Clark Initial Expert Report). Thus, I stand by my initial opinion. Further, it is not essential for all diffraction spots to have the same intensity (nor is it expected) for them to be analyzed, since diffraction spots may go out of contrast over very small (<1˚) angular deviations, such as can be caused by bending in the sample, misalignment of the electron beam with exact low-index direction, etc. This is corroborated by the following images, that were taken on August 2 using conical scan dark field in the probe corrected Titan 80-300 S/TEM. The images show the effect on a series of dark field images of tilting the electron beam. Although the tilts are only in increments of 1˚ (0.5˚ for the final tilt), the effect on the image is clear. Crystallites go in and out of contrast over a very small range of tilt angles. The same will also be true for diffraction patterns.

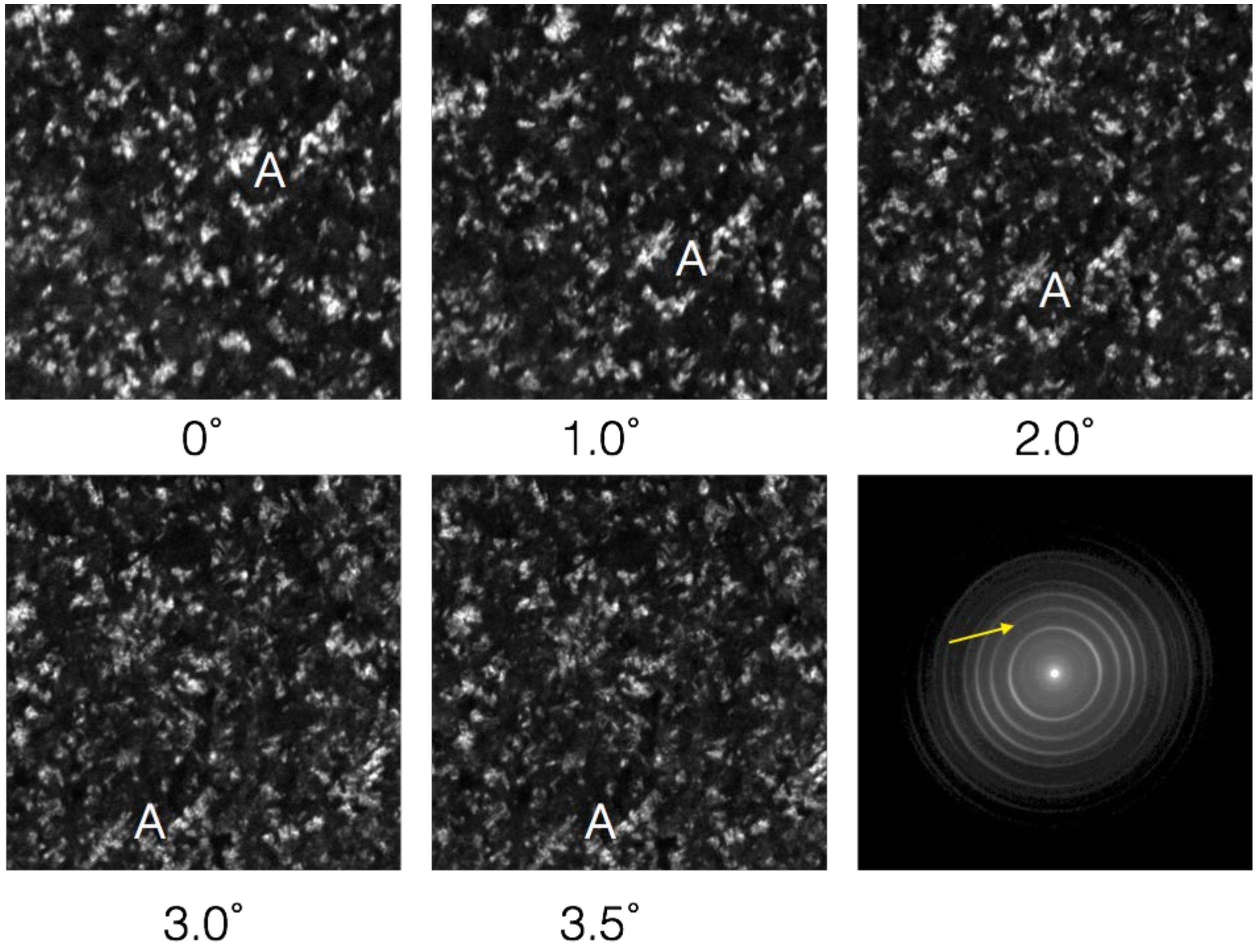

Fig 4 Showing the effect on a dark field image of small sample tilts. The mark “A” is there for reference.

53. Dr. Stach’s criticism in paragraphs 350-351 is flawed. On the patterns in Fig. 48 of Clark Initial Expert Report, all the spots of the {110}BCC motiff are visible. While the two spots Dr. Stach circles may be fainter than others (for the reasons discussed above), they are unmistakably present.

54. Dr. Stach’s criticism in paragraphs 352-353 is also flawed. The doublets of diffraction spots at the corners of the {110}BCC motif are clearly visible and separable, as are the {111}BCC spots in the mid-points of the sides of the motif.

55. For the statements in paragraph 354-355, in order for his analysis and conclusions to be valid, Dr. Stach needs to take measurements from the actual patterns instead of the printed and processed images from the body of my report. Distortion of diffraction patterns is common,

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especially in samples with such small grain sizes, and arise from a variety of sample and instrument factors. However, there is not one other BCC diffraction pattern that can be mistaken for the {110} BCC pattern, and indeed, Dr. Stach does not identify an alternative pattern he believes them to be.

56. In paragraph 356, the statement concerning the Kurdjumov-Sachs variants simply reflects the fact that the ~10˚ misorientation between the {110}BCC crystallites is one that is consistent with two BCC crystallites growing on a {111}FCC surface in two variants of the Kurdjumov-Sachs relationship.

57. With respect to the table prepared by Dr. Stach in paragraph 357, I disagree with his analysis. The diffractions spots in the patterns contain enough information to be fully and properly analyzed consistent with my original analysis in the Clark Initial Expert Report.

58. Contrary to what Dr. Stach states, all of the 1,600 diffraction pattern images I mentioned in paragraphs 360-362 were provided to Dr. Stach as part of the Clark Initial Expert Report.

59. In paragraphs 360-362, Dr. Stach derives an incorrect conclusion based on selectively extrapolating certain of the testing results. The likelihood of obtaining {110} BCC patterns is dependent of the orientation of the sample, which is frequently tilted or may be bent. In a sample with the beam direction close to the FeCo growth direction, the percentage of {110} BCC oriented crystals rises sharply, to approximately 70% for the crystal obtained from the S0GPPC product. Given the very small grain size, crystallites with orientations other than exactly {110}BCC will be captured along with {110}BCC ones, and so may contribute additional spots to the patterns. However, Dr. Stach offers no further information regarding these crystallites, other than making an incorrect conclusory claim that they invalidate the {110}BCC orientation.

60. In paragraphs 364-367, Dr. Stach compares my ring patterns with the ones he obtained. In his own testing, he admits that astigmatism and instrument aberrations (which are extremely hard to avoid in microbeam mode) give rise to distortions in the observed diffraction pattern. *See* Stach ¶ 371. This is exactly consistent with my points in accounting for the slight distortions Dr. Stach observed in the diffraction patterns he criticized in his previous paragraphs.

61. But more fundamentally, Dr. Stach's indexing schematic is incorrect for a BCC ring. Further, I did not use these ring patterns to define grain orientation, but rather to look at those {200}BCC planes making a Bragg angle with the incident beam. The {200}BCC planes making a Bragg angle with the incident beam diffract strongly. I make it clear that the essential feature of the microstructure, and which the Kurdjumov-Sachs orientation helps to provide, is the alignment of the <200>BCC directions in preferred directions in the write head.

62. Based on his analysis of my dark field observations, it appears that Dr. Stach is misunderstanding the points I am trying to make with respect to my observations. The point is that the crystallites that have {200}BCC planes oriented in the Bragg position with respect to the electron beam will appear bright when the objective aperture is placed around just the {200} BCC diffraction ring. When the aperture encloses just a segment of the {200}BCC ring, only those crystallites in which the {200}BCC planes are in the Bragg position and which are also aligned to diffract into the objective aperture will appear bright. In this way, I can determine the angular dependence of the distribution of <200>BCC directions in the head.

63. In paragraph 376-379, Dr. Stach complains about the methodology I used to conduct the dark field imaging. The images were quantified by first setting a black background such that any stray pixel noise was eliminated. Although the image was essentially binary in nature, it was then thresholded such that all the white crystals were captured. The methodology is explained in the Clark Initial Expert Report. The error range was obtained by measuring the area

fraction of bright crystallites on the same image ten separate times. Then, the standard deviation was taken into consideration in this measurement, which amounted to about 10%, as a reasonable estimate of the likely error. This was used for all measurements.

64. As for Dr. Stach's statements in paragraphs 380-383, it is expected that some crystallites, whose orientation lies very close to, or at, the edge of the objective aperture for a given measurement, may contribute to the image taken at the adjacent aperture position. These numbers are very small, and do not affect the results. In addition, the {211}BCC ring mentioned by Dr. Stach is very faint in comparison to the {200}BCC one and does not bias the orientation dependence of the <200>BCC directions.

65. Dr. Stach makes a number of conclusory statements in paragraphs 384-391, but again he missed the point of my analysis. The <200>BCC directions were studied since this is the "easy" magnetization direction in the write head and thus the one with most influence over its performance. *See* Coffey Initial Expert Report. We state very clearly that we do not have any NiFe in the imaged sample. However, the fact that the FeCo crystallites on top of it adopt the same orientation relationships that they would were they in the Kurdjumov-Sachs variants on a {111}FCC template establishes the existence of that epitaxial relation. Dr. Stach confuses the dark field analysis as being dependent on the FeCo crystallites being in a {110}BCC orientation. In fact, that is shown elsewhere in my report, but the dark field analysis is not what establishes that. Dr. Stach's statement in paragraph 389 is confusing. The presence of <200>BCC crystallites around the diffraction ring does not indicate 18 variants. Rather, the tendency for these crystallites to cluster with their <200> directions normal to the write head axis indicates the broken symmetry associated with the six Kurdjumov-Sachs variants is causing uniaxial properties, as described in Dr. Coffey's report.

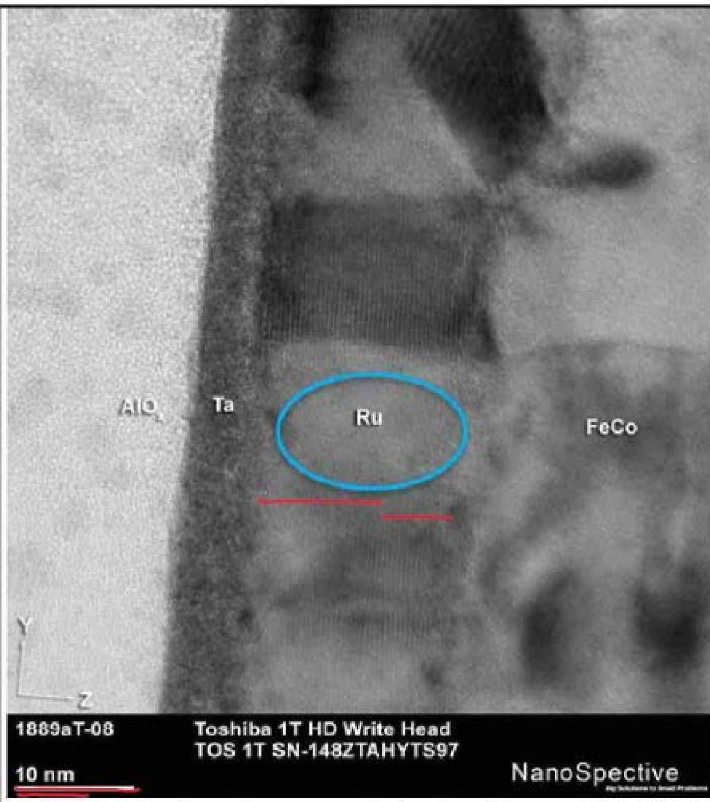
66. Dr. Stach contends in paragraph 391, that because only 32% of crystallites show bright in the dark field analysis, this shows that only a small fraction of crystallites have a (110)

orientation. It should be remembered, however, that a Bragg angle for diffraction at 300kV is less than 1˚, so that crystallites whose <110> lie more than ~1˚ away from the incident beam direction will not diffract, and so will not appear in the dark field image. It is more remarkable that almost 33% of crystallites are oriented with <110> close enough to the beam direction to contribute to the dark field image. This would appear to further support the claim of a {110}BCC texture in the FeCo.

67. With respect to Dr. Stach's statement in paragraph 393, the XRD testing was not conducted on these particular samples because of the limitations imposed by the small dimensions of the heads; the dark field technique was used instead.

a) Response to Dr. Fullerton

68. I disagree with Dr. Fullerton's opinion in paragraphs 391-404 that my microbeam diffraction data contradicts my opinion that the NiFe layers are (111) textured. Dr. Fullerton seems to contend that because I did not identify a hexagonal pattern in the microbeam diffraction measurements, it must not exist. But this is not the case. The (111) textured hexagonal template is likely still present. In the "example" which Dr. Fullerton cites, the underlying atomic template layer in Toshiba's accused products was a Ruthenium layer measuring at least approximately 15 nm thick, which are both factors that allow the hexagonal pattern to be easily observed using microbeam diffraction.



It is a template because it is the layer directly underlying the IronCobalt, which was epitaxially grown thereon.

The fact that the Ruthenium layer is a (111) textured hexagonal structure is confirmed by electron beam diffraction analysis as demonstrated by the hexagon in the diffraction image below:

(LMS's Infringement Contentions (served on Toshiba on Oct. 9, 2015), at 9.)

In contrast, [redacted].

69. I disagree with Dr. Fullerton's analysis in paragraphs 405-421 relating to Figures 49-52 from the Clark Initial Expert Report where he asserts that these figures "do not identify any variants—let alone "two variants in the Kurdjumov-Sachs orientation"—because [they do] not show any (111) hexagonal template crystal." The statements concerning the Kurdjumov-Sachs variants simply reflects the fact that the ~10˚ misorientation between the {110}BCC crystallites is one that can arise from two BCC crystallites growing on a {111}FCC surface in

two variants of the Kurdjumov-Sachs relationship, even though the FCC layer is not captured in this thin film. I also note that we find twinned crystallites in all three write heads, and twinning is one mechanism for propagating variants of the Kurdjumov-Sachs orientation.

70. I disagree with Dr. Fullerton's conclusory statements in paragraphs 455-459. The 86% of patterns that did not contain recognizable patterns are not necessarily "not bcc(110)." They equally well can be bcc(110) tilted slightly off the exact {110} orientation with respect to the electron beam, and thus producing no clear pattern. I note that in the 86% Dr. Fullerton refers to, no crystal orientations that were identifiable as something other than {110}BCC were found. Dr. Fullerton's statement in paragraph 457 is far too sweeping a generalization, for the reasons outlined above. The contentions in paragraph 458 and 459 are also not supported by any data.

71. I disagree with Dr. Fullerton's statement in paragraph 361 that my diffraction data is inconsistent with a (111) Textured NiFe Layer. The ring patterns do not show, and neither do I claim that they show, the texture of either the BCC or FCC layers. They are used to identify crystallites with {200} planes oriented in the Brag position with respect to the electron beam, and hence <200> directions lying in the plane of projection.

72. I disagree with Dr. Fullerton's statement in paragraphs 363-370 that my microbeam diffraction data is inconsistent with a (111) Textured NiFe Layer.[5]

73. I disagree with Dr. Fullerton's statement in paragraphs 467-484 that my "own microbeam diffraction patterns show more than six (110)BCC crystallites with different orientations—and therefore more than six 'variants.'" Because the polycrystalline NiFe material in the Accused Products has multiple hexagonal (111) crystallites in a single layer, each such

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[5] Dr. Fullerton also complains in paragraph 363 that "Dr. Clark also took thousands of microbeam diffraction measurements (most of which he did not produce)"; *see also* footnotes 10 and 11 in paragraphs 394 and 423 of the Fullerton Expert Report. I understand that all microbeam diffraction pattern measurements for all sample products were produced to Seagate on May 2, 2018.

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crystallite has six possible variants that can be epitaxially grown on its surface. Thus, for each crystallite from which microbeam diffraction patterns were taken, there are never more than six variants.

74. I disagree with D. Fullerton's statement in paragraphs that 485-506. Like Dr. Stach, Dr. Fullerton confuses different orientations of {200} planes with variants. The issue is not that there should *only* be orientations that correspond to variants, but rather that symmetry-breaking clusters the {200} planes preferentially in directions perpendicular to the write head.

2. Sample S2MMMC ([redacted])

16. For this product, Dr. Sinclair raises many of the same issues that he raised for the other products. My points and statements made for the other products also apply to this product.

3. Sample SBRD8K ([redacted])

17. For this product, Dr. Sinclair raises many of the same issues that he raised for the other products. My points and statements made for the other products also apply to this product.

75. I disagree with Dr. Stach's criticism of my opinions regarding figure 109. Stach ¶¶ 457-460. The diffraction pattern in figure 109 is immediately recognizable as a diffraction pattern from two twinned crystallites. Dr. Stach ignores the Kurdjumov-Sachs orientation, in which twinning a crystallite that is in the Kurdjumov-Sachs orientation with the substrate will produce a crystallite in a different variant. That is the basis for describing these twinned {110} BCC crystallites in this way.

III. REPLY TO DR. STACH'S "SUMMARY"

76. For the reasons stated above, as well as the analysis set forth in the Clark Initial Expert Report, I disagree with Dr. Clark's conclusory statements in paragraphs 498-499.

A. Reply to "No Evidence of (111) Textured Hexagonal Atomic Template"

77. For the reasons stated above, as well as the analysis set forth in the Clark Initial Expert Report, I disagree with Dr. Stach's conclusory statements in paragraph 500.

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78. Dr. Stach's allegation in paragraph 501 that "NiFe layers with a thickness of [redacted] (which is the target Seagate uses for its products) are unlikely to form any crystal structure, much less have a (111) texture" is purely speculative without any experimental evidence.

B. Reply to "No Evidence of Six-Variant System and Symmetry Broken Structure"

79. For the reasons stated above, as well as the analysis set forth in the Clark Initial Expert Report, I disagree with Dr. Stach's conclusory statements in paragraph 502-505.

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Dated: August 3, 2018

Respectfully Submitted,

William A. T. Clark

Dr. William Alan Thomas Clark